Functional Fibre Reinforced Biocomposites (FUNFIREBIC)

FINAL REPORT

Title of the research project	**Functional Fibre Reinforced Biocomposites**
Coordinator of the project	Markku Nikkilä

BASIC PROJECT DATA

Project period	01.10.2008-30.06.2010
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URL of the project	-

FUNDING

Total budget in EUR	1020072.85 €
Public funding from WoodWisdom-Net Research Programme:	Total funding granted in EUR by source:
Finland Tekes - Finnish Funding Agency for Technology and Innovation	964734 €
Germany Federal Ministry of Education and Research (BMBF)/	55338,85 €

PROJECT TEAM (main participants)

Name, degree, job title	Sex (M/F)	Organization, graduate school	For a visitor: organization & country of origin	Funder
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ABSTRACT

The main objective in FUNFIREBIC project is to produce biocomposites from functionalized wood fibres and biopolymers and to evaluate the feasibility of these biocomposites in injection molded parts for different industrial applications The work focuses in enhancing the adhesion between wood fibre materials and biopolymers by functionalizing the fibres. The project successfully produced pilot scale functionalized fiber biocomposites from laboratory scale to pilot scale and demonstrated the created material in commercial injection molding process.

1.1 Introduction

1.1.1 Background

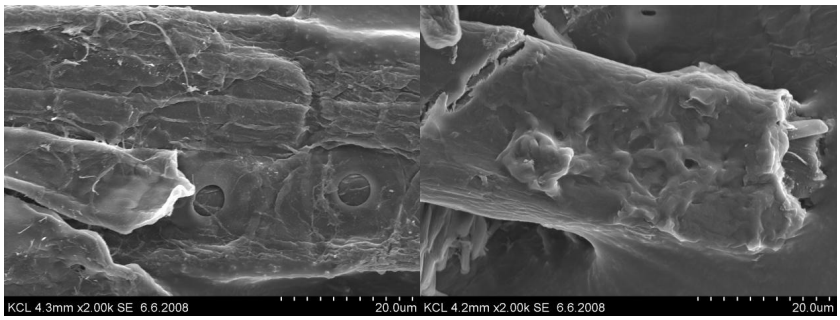
Due to the different characteristics of wood fiber and polymers the composites made from them have been weak and cathegorized as wood fiber filled composites rather than wood fiber reinforced composites. Wood fibers are hydrophilic by nature wherea polymers are hydrophobic. Thus the chemical bond between the two has been weak producing inferior products compared to those in the market.
To promote the connection between the two materials, comatibilizing agents such as maleic andydried are commonly used, however, addin a third component in the composite does not always work and also adds to cost structure of the new material. The relatively expensive pricing of biopolymers make the idea of reinforcing them with relativey cheap wood fibers, quite attractive.

1.1.2 Objectives

To achieve a tailored solution for biopolymers PLA and PHB the project objective was the modification of wood fiber surfaces so that they would have a natural chemical connection to the biopolymers used. This would create a better bond between the two materials but also remove any extra components from the composite to be processed. To achieve these goals, the project worked in laboratory scale in fiber functionization, processing and material characterization and in pilot scale in material production where sufficient amount of materials were produced to be tested at factory level in real products. The objective was to take the new chemical innovation from test tube to factory within the time scope of the project.

1.2 Results and discussion

The project was able to functionalize cellulose fibre surfaces and make them more compatible to bio plastics. The work started at laboratory level. The results were then moved to a pilot plant were the material production was up-scaled to a 100 kg level. The final compounding was done with a twin screw extruder at VTT and shipped over to industrial testing at All-Plast were the final assessment was done with production size injection moulding machines.



Picture 1. SEM images of the reference fibres non-functionalized (left) and functionalized

Picture 2. Fiber samples after 4 hours (left) and 6 hours (right) reaction Time.

Picture 3. A factory floor tested product made from the pilot phase material production.

After the first industrial test runs and feedback from the pilot material material production went through a slight modification to correct a brittleness in the material. The last test runs produced a very acceptable material that could be produced industrially.

1.3 Conclusions

The most important contributions to the state-of-the-art, derived from the results and discussion.

The project successfully produced pilot scale functionalized fiber biocomposites from laboratory scale to pilot scale and demonstrated the created material in commercial injection molding process.

From pure technical point of view gas phase functionalization of the fibers was successful, but larger scale experiments are needed to develop the process into an industrial process.

From a commercial point of view the prices of biopolymers have dropped considerably since the start of the project. The increase in production capacity has made the availability better even for smaller companies. The biopolymer availability on he other hand does not mean that bio based natural fiber composites are more available. From this point of view the project created a new technology to produce these composites. Commercial exploitation of the results would need scaled up pilot production runs to find out the cost structure of industrial production.

1.4a Capabilities generated by the project

The main capability generated by the project is the technical procedure and recipes to produce targeted functionalization to cellulose fibers with a better adhesion to bio polymers without additional chemicals.

1.4b Utilization of results

The project has created the techno- chemical platform for producing functionalized cellulose fibers for producing bio-composites. As stated above the up-scaling to full industrial would need both technical and economical considerations and further work especially with up-scaling of the technology.

1.5 Publications and communication

a) Scientific publications

For publications indicate a complete literature reference with all authors and for articles a complete name. Indicate the current stage of the publishing process when mentioning texts accepted for publication or in print. Abstracts are not reported. Indicate the five most important publications with an asterisk.

1. Articles in international scientific journals with peer review

2. Articles in international scientific compilation works and international scientific conference proceedings with peer review

3. Articles in national scientific journals with peer review

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4. Articles in national scientific compilation works and national scientific conference proceedings with peer review

5. Scientific monographs

6. Other scientific publications, such as articles in scientific non-refereed journals and publications in university and institute series

a) Other dissemination

1. Joint workshop for project coordinators responsible for the ongoing research projects within the WoodWisdom-Net Research Programme
   10. November 2009, VINNOVA, Stockholm

2. WoodWisdom-Net Programme Seminar
   11. November 2009, Clarion Hotel Stockholm

1.6 National and international cooperation

The consortium though physically separated by mere distance managed to work very goal oriented. The key to achieve this were the early on discussions with the scientific and industrial partners in the project and the assessment of resources with regards to the goals set.

The national cooperation was carried on through communicating results and advances on weekly bases. The national partner had scheduled meetings to update the technical advances and schedule.

The international meetings were less frequent and concentrated mainly on checking the results and guiding the next actions to be taken. The international meetings were also the key to check if the work corresponded with the set scientific and industrial goals and handled the conflicts and misunderstandings constructively.

The transnational cooperation enriched the project not only technically and scientifically but also by broadening the understanding of the array of needs different partners communicated.